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OXIDATION CATALYSTS

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8 Claims

ABSTRACT OF THE DISCLOSURE

Hydrocarbon and carbon monoxide content of exhaust gas from internal combustion engines are reduced by contacting the exhaust with a catalyst consisting of copper oxide or copper oxide promoted with silver, cobalt or vanadium oxides on an alumina support.

This application is a continuation-in-part of application Ser. No. 379,720, filed July 1, 1964, which in turn is a continuation-in-part of application Ser. No. 99,380, filed Mar. 30, 1961, now abandoned, which in turn is a continuation-in-part of application Ser. No. 26,699, filed May 4, 1960, now abandoned.

This invention relates to novel catalysts. More particularly, it relates to a method for the oxidation of hydrocarbons and carbon monoxide which are present in the exhaust gas of internal combustion engines.

The exhaust gas of internal combustion engines is composed mainly of the complete oxidation products of the fuel—carbon dioxide and water—and the nitrogen from the air which was fed to the combustion chamber. Relatively minor constituents are oxygen, oxides of nitrogen and sulfur, carbon monoxide and unburned and partially oxidized hydrocarbons. Of this latter group, it is particularly desirable to reduce the concentration of carbon monoxide and of the unburned and partially oxidized hydrocarbons. Carbon monoxide is poisonous and is particularly dangerous because it is difficult to detect, being colorless and essentially odorless. Hydrocarbons, though in themselves somewhat less toxic and harmful, can be asphyxiants if consumed in large volumes. More important is their tendency, by reacting with other atmospheric constituents, to substantially contribute to air pollution. One form of air pollution, a haze-like formation, has been evidenced in certain large cities and is referred to as photochemical smog.

The quality and quantity of unburned and partially oxidized hydrocarbons and carbon monoxide varies widely dependent upon vehicle operating conditions and the conditions of maintenance of the engine. For example, under idle conditions the concentration of unburned hydrocarbons in the exhaust gas may be as low as 300 parts per million; whereas, under decelerating conditions the concentration may be over 5,000 parts per million. Moreover, depending on operating conditions, a variety of partial oxidation products are present in the exhaust gas stream. The failure of just one spark plug to fire will greatly increase the emission of these noxious products.

Various devices have been proposed to treat the exhaust gas stream so as to eliminate the deleterious constituents. Experimental devices such as catalytic converters, afterburners, absorbers (liquid washing devices), porous solid absorbers, condensers, etc., have shown varying degrees of effectiveness. The inherent problems with each device are such that none has achieved commercial

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success. For example in designing an exhaust gas afterburner the problems of maintaining a flame under all operating conditions, and constructing a unit sufficiently small to be installed in modern passenger automobiles have not yet been satisfactorily solved. With liquid washing devices, the large volume and contact time required results in a system much too large to be feasible. Likewise, with adsorbing materials and condensers, problems of the size and efficiency of the system are formidable.

Suggestions of several catalytic converter systems for this application are to be found in the prior art. With such systems, the exhaust gases are passed over a catalytic bed wherein the noxious materials are converted to an inactive form. However, none of these systems substantially meets the requisites of a satisfactory catalytic converter. Among the major requisites for a system employing a catalyst to oxidize the deleterious materials found in exhaust gas streams of automobiles are the following:

(1) Oxidation of substantial amounts of hydrocarbons and carbon monoxide.

(2) The oxidation should be complete, as intermediate products undergo further reactions with other atmospheric constituents and thereby substantially contribute to smog formation.

(3) The discharged exhaust gas should be free of noxious odors.

(4) The catalyst should be active at relatively low temperatures and thermally stable at relatively high temperatures.

(5) It must operate effectively under a wide variety of conditions as hydrocarbon and carbon monoxide content of exhaust gas varies tremendously, depending on whether the car is idling, accelerating, cruising, or decelerating.

(6) It must be particularly resistant to catalytic poisons.

(7) It must be highly resistant to poisonous effects of the oxidation products of the many constituents found in gasoline.

(8) It should preferably not oxidize nitrogen.

The formidable nature of a solution to this problem is better understood by considering the severe environment to which an exhaust gas catalyst is subjected. The catalyst must operate efficiently under a wide temperature range—as low as 400 to 500° F. and preferably lower, and at temperatures as high as 1800° F. It must operate efficiently on the exhaust stream produced from a variety of gasolines burned in a variety of vehicles under a variety of conditions.

In addition to exhaust gases produced by "older type gasolines"; that is, gasoline predominantly composed of aliphatic straight run components, the exhaust device is subjected to the combustion products of modern gasolines. The combustion products of modern gasolines produce a much more severe environment for the catalyst as compared to the exhaust streams produced by older type gasolines. Whereas older gasolines were composed mainly of saturate hydrocarbons producing a somewhat uniform exhaust stream, modernly, gasolines contain a variety of hydrocarbons including high percentages of catalytically produced constituents. These include cracked, reformed, isomerized, and polymerized hydrocarbons. Moreover, modern gasolines contain a multitude of non-hydrocarbon additives designed to effectuate a high degree of combustion efficiency.

In addition, lubricating oils, which often find their way into the combustion chamber and are discharged with the exhaust gas stream also contain non-hydrocarbon additives. It is, therefore, not uncommon that in modern practice an exhaust gas stream will contain the combus-